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USE OF ERTS-1 IN COASTAL STUDIES "Made available under NASA sponsorship
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by

Orville T. Magoon
Special Assistant to the Director
Coastal Engineering Research Center
5201 Little Falls Road, NW
Washington, D.C. 20016

The strong private, public and federal interest in our nation's shorelines is readily apparent from material in the published press and in past and pending legislation. My presentation today reflects the federal involvement in shore protection and planning and also reflects congressional and public recognition of beach and shore erosion as a local as well as a regional problem.

The physical processes which shape our shorelines are extremely complex and diverse. Both natural forces and man-induced changes affect the movement of and supply of sediments along a shoreline. The shores of the United States include practically all known land forms consisting of many materials and at various stages of geologic evolution. These land forms and materials have different vulnerabilities to wave action and their responses to the powerful forces which they oppose form a very broad spectrum. In order to effect realistic coastal planning and sound coastal engineering, it is necessary to quantifiably determine

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WORKING DRAFT

the movement of sedimentary material along the coastline under consideration. Although littoral processes are conceptually understood, it is not yet possible to adequately describe or quantify long or short term forecasts of the effects of improvements or modifications to the shoreline. In some instances, past shoreline changes have resulted in costly damage worth millions of dollars. Research in coastal processes at the Coastal Engineering Research Center is currently directed toward efforts to improve the state-of-the-art on qualitative and quantitative approaches to this problem. A part of these efforts are based on tedious, extremely complex and short-lived insitu sediment transport measurements and experiments.

In addition to the examination of insitu sediment movement at specific locations, it is also necessary to describe and quantify the major coastal processes which occur over large physiographic reaches of our nation's shores. Of the 84,000 miles of the United States' ocean and great lakes shorelines, about 25% is undergoing significant erosion. Almost 3,000 miles of the nation's shoreline are undergoing critical erosion. The cost of remedial measures to halt such erosion, if desired, would be about two billion dollars plus major annual costs. From a practical standpoint, it is impossible to make detailed insitu measurements to describe and quantify the coastal phenomena in all these areas sufficiently to enable the planner and engineer to provide economically and environmentally viable solutions of these problems.

One thus looks for new tools that advance our capabilities in coastal studies. This material will summarize a few of the exciting possibilities of the use of ERTS-1 imagery in coastal studies. The material I am presenting here is very preliminary and is a result of the synergistic contributions of personnel of the NASA-Goddard Space Flight Center and the Coastal Engineering Research Center.

ERTS-1 SATELLITE

The ERTS-1 satellite and its user oriented applications are described in NASA-Goddard Space Flight Center Data Users Handbook, Earth Resources Technology Satellite, Document 71SE4249 with appropriate revisions. Analysis of multi-spectral images is given in reference (2). The Nation's Shorelines are discussed by Sheppard and Wanless in reference (3) and in Report on the National Shoreline Study and 12 related reports (4). Coastal applications of the ERTS-1 satellite are given in (5), (6) and (7). General coastal processes are contained in the Shore Protection Manual (9).

ANALYSIS TECHNIQUES

In analyzing ERTS imagery, analysis was made of 70 mm film available in NASA/ERTS/Goddard browse facility and 9" x 9" color and black and white products. Use was also made of the NASA-Goddard I²S viewer. Images from this viewer were photographed with a 35 mm Leica camera. Available for your examination are a number of mosaics of coastal scenes and a

"ground truth" mosaic made from NASA/Ames ERAP U-2 simulations by Marty Knutson. In addition to the material on display and slides to be shown, Mr. Bob McDonald of the NASA Manned Spacecraft Center, Houston, Texas, is processing some ERTS-1 imagery on the I²S multiple camera film viewer (MCVF) to enhance sediment plumes to the best possible advantage. Copies of this imagery will be furnished to Dr. Nordberg and should be available through his office.

REGIONAL VIEWS

An obvious application of the ERTS-1 imagery is in obtaining regional views of extended coastal areas. An example of this is shown on Display 1 which shows multi-spectral scanner (MSS) bands 4,5,6 and 7 and color composite (Orbit 033 NASA 1024-15073 and NASA 1024-15071 and NASA 1024-15080). Note that a clear line of demarkation along the New Jersey coastal areas is seen on the color composite view. Black and white views show a similar effect. Although readily compiled from ERTS imagery; mosaics made from aerial photography are often extremely difficult to match due to problems inherent with variation of sun angle and camera geometry. This is especially true when comparing the large, well-defined sediment plumes seen in ERTS with attempts to prepare mosaics of areas over water. We thus see in ERTS for the first time the structure of the large coastal and lacustrine plumes associated with

sediment producing areas in many parts of the world. The four channels of the multi-spectral scanner show increasing sediment with decreasing MSS channel number. As shown on Display 2 taken near Admiralty Island, Alaska (Orbit 266 NASA 1019-19430) and consistently shown in other coastal locations, minimum sediment is shown on MSS-7 gradually increasing to maximum sediment on MSS-4. In ERTS imagery where atmospheric haze is a problem on MSS-4, good sediment patterns are shown on MSS-5. Well-defined sediment sources indicate the direction of coastal currents away from the source. A large number of types of sediment plumes have been discussed in the literature. Considerable work on this subject has been supported by the Office of Naval Research and in particular, the Geography Branch. Material in this regard is available from Evelyn Pruitt, Chief of the ONR Geography Branch. The major sediment sources that have been seen in ERTS imagery appear to be derived from river discharges and to a lesser extent from cliff erosion. Sediment plumes are also seen in near Matlaza, Mexico (Orbit 0111, E1008-10762).

COASTAL CONFIGURATION

Information on the predominant direction of littoral movement is often derived from a number of specific shoreline configurations or changes. Particular work in this regard has been published by Galvin regarding coastal inlets (8), and also in the Shore Protection Manual (9). Note particularly on the barrier beaches seaward of Long Island, the strong

overlapping entrances indicating drift towards New York Harbor. Note the similarly occurring spit pointing toward the entrance to New York Harbor on the Delaware side. Although shown on the slides, and more easily seen on the 70 mm originals, the pronounced offset at some coastal inlets is an example of an indication of ^{the} ^{of} direction littoral drift.

BARRIER ISLANDS

One of the major types of natural protection to the shore and thus of great interest to the coastal planner and the coastal engineer are the barrier islands. Due to the large extent of these islands, it is relatively difficult to obtain good synoptic coverage of major portions of the islands after severe storms. One important use of ERTS will be in studying the changes in barrier beaches and barrier islands after severe storms or hurricanes. The precise location capabilities of ERTS will be particularly useful in the measurement of the changes in these islands. Some idea of the capability of ERTS to resolve small features in barrier beaches was shown on a random comparison of a section of ERTS imagery with the Army Map Service scale 1:250,000 sheets. The first is Shishmaref, Alaska and Kotzedue, Alaska. The particular area (Orbit 128) shown on these slides is located between Arctic Lagoon and Cape Essenberg, roughly latitude 66° , 30' north, longitude 165° west. Note that very small features in the smallest

channels are clearly seen. A new inlet or closed inlet would be easily detected. These slides were simply made by using my 35 mm camera to copy from a ground glass projection of the 70 mm ERTS film. Note also that in several areas of the map, lakes previously shown are no longer visible. The photography used to generate the AMS sheets was taken in the July-August period which is a similar time of year. I would estimate that the inlets channel are in the range of three to four hundred feet wide. The interface between land and water is, of course, particularly enhanced by the infrared bands. As a simple expedient in comparing the ERTS imagery with the chart, I projected the 35 mm slide onto the appropriate topographic maps held up in front of the screen.

UNDERWATER PENETRATION

During examination of the ERTS imagery, it is clear that considerable underwater penetration is possible under the appropriate conditions. This will be particularly useful in detecting, for example, changes in underwater sand formations such as those located between Florida and the Bahamas. Considerable penetration was also observed in ERTS imagery of tropic waters where the comparison between various bands of the multi-spectral scanner gives an indication whether the phenomena being observed is at the surface or under water. Analysis of results from specific test sites will be required before detailed results can be presented.

An interesting fringing reef which shows up well on RBV1 around Poeloe Besar, Flores, Indonesia (see HO Chart 3090) (Orbit 46 NASA E1004-01241).

COASTAL WAVES

In viewing ERTS imagery of coastal areas, particular attention was paid to areas where coastal waves might be present. Although not clearly seen on the slides breaking waves on the coast and around a coastal bay mouth bar were located along the Spanish-Sahara coast (Orbit 0205 NASA E1015-01523). Waves are in the series of small dots along the coast and out over the bay mouth bar. Unfortunately, these did not reproduce on the duplicate slides. Breaking waves along a bar ten miles in length are seen on the coast of Mozambique (Orbit 0119 NASA E1009-07064), both on the RBV and MSS channels. Breaking waves also appear on the north side of bars along the New Jersey coast (Orbit 0333 NASA 1024-15073). Additional analysis will undoubtedly reveal other areas of breaking wave identification. In areas of high waves in deep water with appropriate sun angles, it is expected that long straight deep water waves as seen in the U-2 simulation flights will be observed in ERTS imagery.

CONCLUSIONS

Only a few samples of the ERTS-1 imagery to coastal studies have been presented. Even with the limited inspection possible of available imagery, a number of clearly demonstrated applications of

ERTS to coastal studies have been described. The author would welcome results and reports from other investigators regarding the coastal and nearshore applications of ERTS imagery.

ACKNOWLEDGEMENTS

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the Chief of Engineers to publish this information is appreciated. The findings of this paper are not to be construed as official Department of the Army position unless so designated by other authorized documents. The review and comments on the manuscript and continued support by LTC Don S. McCoy, Director, CERC are gratefully acknowledged.

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DEPARTMENT OF THE ARMY
COASTAL ENGINEERING RESEARCH CENTER
5201 LITTLE FALLS ROAD, N.W.
WASHINGTON, D.C. 20016

CEREN-EV

25 September 1972

MEMORANDUM FOR RECORD

SUBJECT: Review of ERTS 1 mosaics of Atlantic Shoreline of Maryland, Delaware, New Jersey, New York and Connecticut

1. At the request of Remote Sensing Coordinator, Mr. Orville T. Magoon, I reviewed approximately two dozen frames of ERTS 1 imagery. This review was to determine the applicability of such imagery for use in coastal engineering.

2. General Comments concerning mosaics composed of frames 15080, 15073, 15071:

A. Continuity from frame to frame is excellent allowing mosaics to be formed easily.

B. Bands 4 & 5 appear to be the best suited for coastal morphology work. The color composite delineates features but not to the same degree.

C. Anomalies in printing destroy some usefulness in analysis such as Newtonian rings, dust and hair particles in prints.

3. Specific comments:

A. Frame 15080 Band 4

1) To the south of Assateague Island excellent rendition of sediment patterns in water. Two possible conclusions without further confirmation; one, sediments in suspension which may be coming out of Chincoteague Inlet or two, bottom bathymetry of large scale shoals known to be in the area.

2) These patterns of sediments are easily noted along most of the shoreline of Assateague Island.

3) On the island itself the large feature known to be the remnant of an overwash fan are easily seen (site of CERC pier), also visible is a cleared land area just north of overwash fan and the bridge connecting the island to the mainland.

4) The sediment patterns bend out around the inlet to Ocean City Md. (in mosaics frame 15073) and appear to indicate a northward movement of littoral materials.

5) On the southeast portion of the frame in the portion of the ocean not covered by clouds there appears a mottled appearance to the

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ocean. This feature is not a result of the cloud shadows and may be assumed to be bathymetry - correlation to detailed charts needs to be made. Some statement for features in northeast corner of frame.

B. Frame 15073

1) In all bands (4, 5, 6, 7 and composite) two inlets are easily identified up to the entrance to Delaware Bay. 8 inlets are visible north of the Bay entrance.

2) The sediment patterns in bands 4 & 5 indicate that a deep water channel is present on the south side of the Bay entrance.

3) The sediment pattern from the Bay entrance indicate a northerly drift direction. This is further confirmed by the plume at Absecon Inlet (Atlantic City).

4) Although not measureable it is visible without aids that a major feature (man-made) projects from the shoreline at Atlantic City, in all probability the Steel Pier. (only in bands 4 & 5 & color composite)

5) In the northeast portion of this frame in bands 4 & 5 there are marked linear patterns striking a NE-SW orientation; these continue into frame 15071. They apparently are real - cause unknown; supposition, bottom bathymetry or marked laminations of the water caused by strong differentials in water temperature or salinity.

6) The inner and outer bars at inlets are easily defined especially in Band 5 at Hereford Inlet, Corson Inlet. Great Egg Inlet, Brigantine Inlet, Little Egg Inlet.

7) The navigation improvements (jetties) at Cape May & Absecon Inlet are seen by the evident straightening of the inlets on the north & south sides of each inlet respectively.

8) There is a especially strong disturbance in the long shore current in the vicinity of Atlantic City (shows very strongly in bands 4 & 5). No apparent reason for causing the sediments to be "pushed" to sea for such a distance. Although this plume and others indicate a northerly drift the strong disturbance at this point may be the result of both a northerly & southerly current meeting at this point.

9) In this frame and the next (15071) a strong lineation in the land west of the barrier islands indicates a former coastline. This appears in Bands 4, 5, 6 and the color composite.

C. Frame 15071

1) This frame shows the northerly portion of N. J., Hudson River mouth, Long Island a portion of Long Island Sound and Conn.

2) In bands 4 & 5 the sediment plume leaving the entrance to

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the Hudson River shows movement in a southerly direction contrary to what had been seen in the previous frames and possibly explains what has happened to the sediments in the vicinity of Atlantic City.

3) The two curious recurved patterns southeast of the river mouth evoke in any interesting comments from the possibility of material being dumped by New York City's honey bucket barges to vapor trails from circling jets waiting to land at Kennedy Airport. Based on comparisons of bands 4 & 5 (more strongly in 4) I would lean to the first guess. The separation of the two broadly distributed sediment patterns, the first from the N. Y. Harbor, Hudson River area and the second surrounding the items of interest and their merger southward would indicate that these two patterns (actually 3) are in the area known as Cholera Band and used as a dump grounds. [Note: these patterns in the color composite have characteristics similar to those observed in color IR photographic of sodium fluorescen dye injections at Point Mugu taken by Teleki.]

4) In band 4 there is a strange sediment pattern in shape of an arrowhead immediately south of Fire Island Inlet. This may indicate a relatively strong, sediment free, flow of water moving towards Long Island in a northerly direction. As this flow approaches the shoreline it is forced to spread in an easterly and westerly direction by dominant along-shore currents. The apparent lack of this feature in the other bands especially 5 and the color composite is unknown. Supposition; the separation in wave lengths of bands 4 and 5 may reveal features at different depths; without further information or correlation by ground based data it remains a supposition, but an interesting possibility for discriminating water currents existing at selected depths.

D. Throughout all frames the back bay features are clearly definable. Within each band there are marked differences in geometry of these areas. It is known that the IR region of course defines the water/land interface but bands 4, 5, and 6 apparently indicate some capability for water depth penetration. If this capability can be quantified then a bathymetric chart of the areas could be constructed - other passes at different tide levels would add more definition to this product.

4. Based on review of the mosaics of frames 15080, 15073, 15071 in the 4 separate bands and the color composite it is recommended that for coastal work, imagery should be examined in band 4, 5, and 7. Although for presentation purpose the color composite is a show stopper the information contained therein is not as useful as the black & white bands.

5. This review and examination was accomplished by the undersigned in

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Delaware, New Jersey, New York and Connecticut

approximately 2 hours without the assistance of visual aids or reference material (other than a road map).

6. Prior to construction of any future mosaics by this office using ERTS 1 imagery it is strongly suggested that information on frame borders be transferred to the mounting board or left intact on all edges other than those cut for mating one frame to another. Although these mosaics are easily identified and geographic coordinates could be reconstructed such coordinates are already notated.

DENNIS W. BERG
Chief, Evaluation Branch

ERTS-1 Image Analysis

Orville T. Magoon
Coastal Engineering Research Center
5201 Little Falls Road, N.W.
Washington, D.C. 20016

Goddard Archive Library Roll No. _____

Bulk Image Annotation Block Data

Day/Month/Year _____

FRAME ID	Format Center	CN	_____ - _____/W _____ - _____
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	RBV2		
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E A D D D - H H M M S - B C R R

General Location: _____

Importance: Outstanding _____ Major _____ Good _____ Marginal _____

REMARKS: _____

